

CLASSIFICATION CONFIDENTIAL **CONFIDENTIAL**
 CENTRAL INTELLIGENCE AGENCY REPORT
 INFORMATION FROM CD NO.
 FOREIGN DOCUMENTS OR RADIO BROADCASTS

50X1-HUM

COUNTRY USSR
 SUBJECT Scientific - Radio, transmitters
 HOW PUBLISHED Book
 WHERE PUBLISHED Moscow
 DATE PUBLISHED 1950
 LANGUAGE Russian

DATE OF INFORMATION 1950

DATE DIST. 1 Aug 1951

NO. OF PAGES 6

SUPPLEMENT TO REPORT NO.

THIS DOCUMENT CONTAINS INFORMATION AFFECTING THE NATIONAL DEFENSE OF THE UNITED STATES WITHIN THE MEANING OF ESPIONAGE ACT 80 U. S. C. 31 AND 32, AS AMENDED. ITS TRANSMISSION OR THE REVELATION OF ITS CONTENTS IN ANY MANNER TO AN UNAUTHORIZED PERSON IS PROHIBITED BY LAW. REPRODUCTION OF THIS FORM IS PROHIBITED.

THIS IS UNEVALUATED INFORMATION

SOURCE

Radiopredavushchiye Ustroystva, Svyaz'izdat

484 pp.

50X1-HUM

INFORMATION FROM THE BOOK "TRANSMITTING EQUIPMENT"
 BY Z. I. MODEL' AND I. Kh. NEVYAZHSKIY

INTRODUCTION

The development of vacuum-tube oscillator and transmitter techniques is due in considerable degree to the work of Soviet scientists and engineers. Professor M. A. Bonch-Bruyevich played an outstanding role. He developed the most powerful tubes in his time (having powers of 30 kw in 1922 and 100 kw in 1925). He was the first in the world to introduce the principle of water-cooling for tubes, developed and constructed the first powerful vacuum-tube transmitters, and devised a number of original radiotelephone circuits. He designed the first radio broadcasting station, imeni Komintern, with a power of 12 kw in 1922 and designed another with a power of 40 kw in 1927. Both of these stations were for their time the most powerful in the world.

Academician M. V. Shuleykin had much to do with the development of theoretical knowledge in the field of transmitting equipment. His practical and theoretical work, begun even before World War I, covered a variety of problems relating to oscillators, antennas, modulation, etc. In his pedagogical activity, Shuleykin and Professor I. G. Freyman (who wrote the outstanding text A Course in Radio Engineering), demonstrated the thorough theoretical analysis needed as a basis for engineering calculations.

The difficulty in making calculations for the vacuum-tube oscillator was due to the complex form of the static characteristics of tubes. Shuleykin devised linear idealized characteristics, and from these, Soviet scientists devised methods to calculate triode, and subsequently tetrode and pentode oscillators. These scientists include: A. I. Berg, A. L. Mints, I. G. Klyatskin, B. P. Aspyev, S. I. Yevtyanov, V. N. Sosunov, S. A. Drobov, etc. The method of calculating an oscillator was later perfected through the work of Academician A. I. Berg, who developed a strict method for calculating an oscillator applicable for any type of operating conditions. The method of calculating an oscillator given in this text is based upon Berg's method.

CONFIDENTIAL

- 1 -

CLASSIFICATION		<u>CONFIDENTIAL</u>		DISTRIBUTION							
STATE	<input checked="" type="checkbox"/> NAVY	<input checked="" type="checkbox"/> NSRB									
ARMY	<input checked="" type="checkbox"/> AIR	<input checked="" type="checkbox"/> FBI									

CONFIDENTIALCONFIDENTIAL

50X1-HUM

Problems involved in the operation of self-excited oscillators, their frequency stability, etc., were solved largely through the works of Soviet scientists. They include Academicians L. I. Mandel'shtam and N. D. Papaleksi, who created the school of nonlinear radio engineering, A. I. Berg, D. A. Rozhanskiy, M. S. Neyman, B. K. Shembel', G. A. Zeytlenok, S. I. Yevtyanov, Yu. B. Kobzarev, V. N. Sosunov and others.

The change to independent excitation caused great difficulties, particularly in the construction of short-wave and ultrashort-wave transmitters because of tube capacitances which created close coupling between the plate and grid circuits in each stage; the problem of neutralization of this coupling had to be solved. Soviet radio specialists took a leading part in the study and development of neutralization circuits (G. A. Zeytlenok and others). Most short-wave and ultrashort-wave transmitters built both in the USSR and abroad used the grounded-grid circuit proposed in 1929 by Bonch-Bruyevich.

The rapid increase in the power of radio broadcasting stations up to hundreds of kilowatts was due to Soviet specialists. Particular credit for the development of powerful radio transmitters should be given to A. L. Mints, Corresponding Member of the Academy of Sciences USSR. Original methods of combining the powers of vacuum-tube transmitters, methods now used both in the USSR and abroad, were first developed in the construction of powerful Soviet broadcasting stations.

The construction of transmitters for shorter wave lengths, including the meter band, led to a number of engineering developments by Soviet Specialists A. M. Kugushev, I. S. Gonorovskiy, B. P. Terent'yev, A. I. Lebedev-Karmanov, Z. V. Topuria, B. I. Ivanov, and others.

The advancement of transmitting techniques into the field of superhigh frequencies made necessary the study of new very complex phenomena and the development of radically new electronic instruments, new types of circuits, and new systems for channelling and radiating high-frequency energy. Much credit for the solution of these problems belongs to the following Soviet scientists: Academician B. A. Vvedenskiy, G. A. Grinberg, A. A. Slutskin, M. S. Neyman, V. I. Kalinin, S. A. Zusanovskiy, S. D. Gvozdever, V. S. Lukoshkov, and others.

As far back as 1923, S. I. Zilitinkevich discovered high-frequency oscillations in a triode based upon the phenomenon of electron inertia. These oscillators, the so-called oscillators with a retarding grid, were not used in practice (and therefore they are not discussed in this book), but they promoted a more thorough study of inertia effects involved in the development of radically new electronic devices (klystrons and magnetrons) and special triode designs for generation of very high frequencies.

Before World War II, it was still not decided which of these types of oscillators would be used most in the future, until D. Ye. Malyarov and F. N. Alekseyev proposed the design of the multislotted magnetron, which is now the main source of powerful superhigh frequency oscillations.

In this text, principal attention has been given to transmitters designed for communications and radio broadcasting, using the usual triodes, tetrodes, and pentodes. The processes occurring in the generation of very high frequencies have been left to the last part of the text.

- 2 -

CONFIDENTIAL**CONFIDENTIAL**

CONFIDENTIALCONFIDENTIAL

50X1-HUM

TABLE OF CONTENTS

	<u>Page</u>
Introduction	3
Part I. Generation and Amplification of High-Frequency Oscillations	
I. Basic Properties of Electron Tubes	
1. Diodes and Triodes	11
2. Tubes With a Screened Plate <u>Tetrodes and Pentodes</u>	16
II. Oscillatory Circuits	
1. Simplest Oscillatory Circuit	21
2. Resonance Curves	27
3. Resistance of the Circuits for Harmonics	30
4. Complex Resonance Circuits	32
5. Coupled Circuits	34
III. The High-Frequency Vacuum-Tube Oscillator	
1. Oscillations of the First and Second Types	44
2. Power Considerations and Types of Operation of the High-Frequency Oscillator	49
3. Form of Plate Voltage Oscillations in the Oscillator	46
4. Grid Circuit of the Oscillator	54
5. Use of Tubes With a Screened Plate	55
IV. Theory and Calculation of the Vacuum-Tube Oscillator	
1. Linear Idealized Static Characteristics	58
2. Concept of the Plate Current Cutoff Angle <u>Operating Angle</u>	60
3. Separation of a Peaked Cosinoidal Pulse Into Components	63
4. Operating With a Tuned Oscillatory Circuit	66
5. Dynamic Characteristic. Operating Conditions of the Oscillator in the Boundary Region	68
6. Equivalent Circuit of an Oscillator	71
7. Operation of the Oscillator to Give a Flat-Topped Wave Form	72
8. Grid Circuit of the Oscillator	74
9. Characteristics of the Calculation of Tetrode and Pentode Oscillators	75
V. Technical Calculations for Vacuum-Tube Oscillators	
1. Summary of Formulas Used in Calculations	79
2. Approximate Calculation	82
3. Technical Calculation	84
VI. Vacuum-Tube Oscillator Circuits	
1. Oscillatory Circuits in the Plate Circuit of the Oscillator	92
2. Plate Supply Methods <u>Parallel and Series Feed</u>	97
3. Grid Circuit of the Oscillator	101
4. The Push-Pull Oscillator Circuit	107

- 3 -

CONFIDENTIAL**CONFIDENTIAL**

CONFIDENTIALCONFIDENTIAL

50X1-HUM

	<u>Page</u>
VII. Tuning a Separately Excited Vacuum-Tube Oscillator	
1. Tuning Problem	116
2. Effect of U_g , E_g , and R_{oe}	117
3. Operation of the Oscillator With a Detuned Load	118
4. Procedure in Tuning the Oscillator	121
VIII. A Self-Excited Vacuum-Tube Oscillator	
1. Concept of Self-Excitation	122
2. Self-Excited Oscillator Circuits	123
3. Self-Excitation Conditions	129
4. Frequency of Oscillations. Self-Excitation Equation	134
5. Coupling-Hysteresis Effect	136
6. Generation of Dynatron Oscillations	138
IX. Higher Harmonics in Oscillator Circuits	
1. Frequency Multiplication	141
2. Increasing Oscillator Power and Efficiency by Using Harmonics	145
3. Reduction of Oscillator Efficiency Because of Harmonics	145
4. Filtering Harmonics	147
Part 2. Control of High-Frequency Oscillations (Amplitude Modulation and Manipulation)	
X. General Information on Amplitude Modulation	
1. Basic Methods of Radiotelephone Modulation	155
2. Analysis of Modulated Oscillations	160
3. Power Balance	163
4. Modulation and Frequency Characteristics	165
XI. Grid Modulation	
1. Grid-Bias Modulation	169
2. Basic Circuits for Grid-Bias Modulation	178
3. Modulation by Changing the Excitation Amplitude. Amplification of Modulated High-Frequency Oscillations	182
XII. Plate Modulation	
1. Linearity Conditions for the Static Modulation Characteristic	191
2. The Plate Circuit of the Oscillator for Modulation	194
3. Calculation of the Oscillator	198
XIII. Plate Modulation Circuits	
1. General Considerations	203
2. Straight Modulator Circuits	204
3. Balanced (Push-Pull) Class B Modulator	208
XIV. Modulation for Screened-Plate Tubes	
1. Modulation in the Tetrode Oscillator	223
2. Modulation in the Pentode Oscillator	224

- 4 -

CONFIDENTIAL**CONFIDENTIAL**

CONFIDENTIALCONFIDENTIAL

50X1-HUM

Page

XV. Telegraph Manipulation	
1. Types of Telegraph Signals	227
2. Telegraph Manipulation Circuits	229
Part 3. Transmitters	
XVI. Characteristics of Transmitters	
1. General Considerations	235
2. Electric and Acoustic Indexes	235
3. Block Diagram of a Transmitter	241
4. Construction of Transmitters	243
XVII. Stabilization of Transmitter Frequency	
1. Factors Affecting Frequency Stability of an Oscillator	246
2. Variable-Frequency Oscillator	249
XVIII. Quartz Stabilization	
1. Physical Properties of Quartz	257
2. Equivalent Circuit of Quartz	259
3. Calibration and Stabilization Properties of a Quartz Circuit	261
4. Quartz Oscillators	263
5. Quartz Stabilization on a Wave Band	268
XIX. Neutralization	
1. Basic Problems of Neutralization	270
2. Basic Properties of Bridge Circuits	273
3. Neutralization of Straight Circuits	275
4. Neutralization of Push-Pull Circuits	279
5. Practical Neutralization Methods	282
6. Neutralization With the Help of Complex Bridge Circuits	285
7. Screened-Plate Tubes	289
8. Grounded-Grid Tubes	291
XX. Parasitic Oscillations in Transmitters	
1. General Information	295
2. Push-Pull Parasitic Oscillations	296
3. Straight Parasitic Oscillations	299
4. Measures to Reduce Parasitic Oscillations	300
5. Other Types of Oscillations	306
6. Methods for Detecting and Suppressing Parasitic Oscillations	306
XXI. Quality Indexes of Radio Transmitters	
1. Frequency Distortion in the Radiotelephone Transmitter	310
2. Nonlinear Distortion and Parasitic Modulation (Hum)	321
3. Reduction of Distortion by Negative Feedback	324
4. Distortion in Telegraph Manipulation	329

- 5 -

CONFIDENTIAL**CONFIDENTIAL**

CONFIDENTIALCONFIDENTIAL

50X1-HUM

Page

XXII. Characteristics of Long- and Medium-Wave Transmitters	
1. Design of the Transmitter Circuit	335
2. General Information on High-Frequency Components	342
XXIII. Characteristics of Short-Wave Transmitters	
1. Basic Characteristics	348
2. General Information on High-Frequency Components	350
3. Design of the High-Frequency Stages	356
XXIV. Characteristics of Ultrashort-Wave (Meter Wave-Length) Transmitters	365
1. Basic Elements of the Ultrashort-Wave Oscillator	366
2. Self-Excited Ultrashort-Wave Oscillator	369
3. Design of Ultrashort-Wave Transmitters	373
XXV. Special Types of Modulation and Manipulation	
1. Single Side-Band Transmission	377
2. General Information on Phase and Frequency Modulation	383
3. Phase and Frequency Modulation Circuits	388
4. Frequency Manipulation	391
5. Pulse Manipulation	394
6. Multichannel Transmission	401
7. Pulse Modulation	405
Part 4. Decimeter- and Centimeter-Band Oscillators	
XXVI. Interaction of Electrons With an Electric Field	
1. Movement of an Electron in an Electric Field	417
2. Convection and Induced Currents	421
3. Effects in a Triode	426
XXVII. Triode Oscillators	432
XXVIII. Klystron Oscillators	
1. Double-Loop Klystrons	441
2. Reflex Klystrons	449
XXIX. Magnetron Oscillators	
1. General Information on Magnetrons	453
2. Movement of Electrons in Magnetrons	458
3. Frequency of Oscillations and Operating Conditions of the Magnetron Oscillator [pages 468-469 and 472-473 missing]	465
Appendexes	
1. Table of Oscillator and Modulator Triodes [missing]	476
2. Table of Screened-Plate Oscillator Tubes (Tetrodes and Pentodes).	
Gives characteristics of the following tubes: tetrodes -- G-832, G-807, G-1625, G-829, GKE-100, G-813, GKE-500, GKE-1000, and G-827; pentodes -- P-6, P-15, G-411, G-837, G-413, P-50, G-471, P-800, and G-425.	478

- E N D -

- 6 -

CONFIDENTIAL**CONFIDENTIAL**